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## PROGRAM CHARTER

For

Climate Research and Modeling

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### 1. EXECUTIVE SUMMARY

The overarching goal of the Climate Research and Modeling program is twofold: 1) to develop and improve the capability to make weekly, intraseasonal, seasonal, decadal, and centennial-scale predictions of climate and (2) to understand changes in atmospheric composition, understand past and present climate change and make future climate projections from global to regional scales. This will enable regional and national managers to better plan for the impacts of climate variability and change and provide accurate, objective climate assessments and projections to support policy decisions.

An emerging focus of the capability is on the decadal time-scales, which will influence decision making processes. To advance decadal predictions, whose acceptance is dependent on confidence in understanding and modeling of the climate system, observations of the slowly varying components of the climate system need to be assimilated, and rapidly varying components such as radiative forcing agents like aerosols and ozone need to be calculated and accurately represented.

A key requirement for predictions and projections is models that embody sufficient realism in terms of process understanding, sufficient spatial resolution, and improved physics. To achieve its objectives, this program maintains and implements real-time climate monitoring data sets and the next-generation suite of operational climate products and assessments, incorporating improvements in climate models and forecast generation techniques. This program also develops estimates of changes in atmospheric composition (including atmospheric chemistry, carbon and other biogeochemical cycles) and future changes in climate forcing agents; and it maintains and develops leading edge Earth System models for the understanding of past climate change, interpretation of present climate events and trends, and projection of future climate change on global to regional scales. Activities under this program are spread across several line offices and NOAA laboratories, and also support and leverage competitively reviewed research.

The Climate Research and Modeling Program maintains capabilities that include (1) understanding climate processes, (2) Earth System modeling, prediction, and projection, leading to understanding climate variations, change, and predictions, and (3) climate analysis and attribution. These capabilities contribute to the Climate Service Development Program. Activities within these capabilities include (i) operational forecasts and assessments, (ii) research and development for predictive understanding of the climate system, (iii) making use of observations for advancing climate modeling and research, (iv) measurements and understanding of non-CO<sub>2</sub> radiative forcing agents, (v) improving estimates of climate forcings and understanding their causes, (vi) understanding and prediction of ozone layer recovery, (vii) projections of future climate change, (viii) analysis of the climate system, and (viii) attribution of past and present climate variations and change.

### 2. PROGRAM REQUIREMENTS

A. Legislative and Directive Documents establishing needs and requirements:

1) Legislation:

- a) National Weather Service Organic Act (15 U.S.C. §313): Outlines NOAA's responsibility to produce climate forecasts.

- b) National Climate Program Act, 15 U.S.C. 2901-2908, at 2904(d) (4), et seq.: This act authorizes global data collection, monitoring and analysis activities to provide reliable, useful and readily available information on a continuing basis. In addition, the act authorizes measures for increasing international cooperation in climate research, monitoring, analysis and data dissemination.
  - c) Global Change Research Act (15 U.S.C. §2921 et seq.): This act mandates the development of a research program the goal of which is to understand climate variability and its predictability. It also mandates research and observation of human activities that may lead to global changes and may adversely affect society (i.e., global warming and stratospheric ozone depletion).
  - d) Global Climate Protection Act of 1990, 7 U.S.C. § 6701 et seq.: Requires research in climate change needed to protect the environment. The CRM Program produces results used for decision support for protecting the environment.
  - e) Coastal Zone Management Act of 1972 (16 U.S.C. §1450 et seq.): Requires understanding and prediction of long-term climate change that may have large impacts in the coastal zone, such as global warming and associated sea level rise.
- 2) Interagency or International Agreements:
- a) Strategic Plan for the Climate Change Science Program (CCSP): Requires reduced uncertainty in projections of how the Earth's climate and related systems may change in the future. Requires federal agencies to carry out research to quantify climate forcing by various agents, reduce the uncertainties in the evaluated forcings, produce timely predictions, as well as generate synthesis and assessment products (SAPs) on various aspects of climate change.
  - b) Ocean Research Priorities Plan (ORPP): Presents research priorities that focus on the most compelling issues in key areas of interaction between society and the ocean, including the Atlantic Meridional Overturning Circulation (AMOC) and abrupt change. Provides guidance on how the various ocean science sectors (government, academia, industry, and non-government entities) can and should be engaged, individually or through partnerships, to address the areas of greatest research priority and opportunity.
  - c) U. N. Framework Convention on Climate Change (UNFCCC): Requires better quantification of the agents that force climate change by countries contributing research results and providing expertise to the assessments.
  - d) Montreal Protocol on Substances that Deplete the Ozone Layer (and subsequent amendments): Requires an assessment every four years of the state of the ozone layer, its recovery, and the amounts and origins of ozone depleting substances that drive the ozone layer changes. The influence of climate change on the future of the ozone layer and the consequences of ozone layer changes to the climate system also must be addressed through research and assessments.

#### B. Mission Requirements

- 1) Understand and predict climate variability on timescales ranging from intraseasonal through seasonal to decadal and beyond (Global Change Research Act).
- 2) Monitor, assess, and forecast climate (National Weather Service Organic Act).
- 3) Understand and predict long-term climate change and evaluate its impacts on the coastal zone (Coastal Zone Management Act).
- 4) Improve climate models to reduce uncertainty in projections of Earth's climate (Strategic Plan for the Climate Change Science Program).

- 5) Improve knowledge of observed variability and change of the Earth's past and present climate and environment (Strategic Plan for the Climate Change Science Program).
- 6) Improve quantification of the forces bringing about changes in the Earth's climate system (Strategic Plan for the Climate Change Science Program).
- 7) Monitor and understand changes in the ozone layer and ozone depleting gases and assess the consequences of changes (Global Change Research Act).
- 8) Provide monitoring, assessment, and analysis of the climate system through high-quality observations and measurements of atmospheric, oceanic, and select terrestrial variables, as well as modeling capabilities (Global Change Research Act, National Weather Service Organic Act, Coastal Zone Management Act, US Ocean Action Plan).

### 3. LINKS TO THE NOAA STRATEGIC PLAN

NOAA Climate Mission Goal: Understand climate variability and change to enhance society's ability to plan and respond.

- A. Goal Outcome: A predictive understanding of the global climate system on times scales of weeks to decades to a century with quantified uncertainties sufficient for making informed and reasoned decisions.
- B. Goal Performance Objectives: Understand and predict climate variability and change from weeks to decades to a century.
- C. Goal Strategies
  - 1) Provide the research needed to understand climate processes, including products providing information on atmospheric composition. (This includes coordination with the NOAA 5-Year Research Plan.)
  - 2) Provide the resolution and accuracy for prediction and projection services related to future states of the climate at a scale required to meet user demand.
  - 3) Develop Earth system models with advanced assimilation systems to facilitate attribution studies and increase the length of time for which prediction is possible.
  - 4) Improve the quantification and understanding of the forces bringing about climate change by examining relevant human-induced increases in atmospheric constituents.
  - 5) Develop and contribute to routine state-of-the-science assessments of the climate system for informed decision-making.
  - 6) Work with customers in order to deliver climate services and information products related to health, safety, environmental, economic, and community planning that increase the effective application of this information.

### 4. PROGRAM OUTCOMES

- A. Support operational outlook, assessment, and application development on intraseasonal, seasonal, and decadal time-scales to enable national, regional, state, and local managers to take proactive actions in response to the impacts of climate variability and change.
- B. Produce climate change projections in support of informed policy decisions that mitigate societal impacts of climate trends.
- C. Improved understanding of carbon cycle processes and feedbacks, and quantification of carbon sources and sinks, enabling the prediction of future atmospheric carbon dioxide concentrations.
- D. Produce information on the climate roles of radiatively important fine-particle aerosols, with an emphasis on aerosol-cloud interaction (the most uncertain of the climate forcing agents) and non-carbon dioxide greenhouse gases to provide decision support associated with

options for potential near-term changes in radiative forcing of climate change.

- E. Produce information for the verification of the recovery of the ozone layer and the decline of ozone-depleting chemicals in the atmosphere, thereby facilitating compliance with the Montreal Protocol and safeguarding the Earth's ultraviolet shield.
- F. Contribute to major national and international assessments concerning changes in atmospheric composition and climate change for policy and decision support.

## 5. PROGRAM ROLES AND RESPONSIBILITIES

This program is established and managed with the procedures established in the NOAA Business Operations Manual (BOM). The CRM Program directly supports the other Programs under the NOAA Climate Mission Goal. CRM also contributes to the other four NOAA Mission Goals, Ecosystems, Weather and Water, Commerce and Transportation, and Mission Support. Responsibilities of the Program Manager are described in the BOM. Responsibilities of other major participants are summarized below.

### A. Participating Line Offices, Staff Offices, and Council Responsibilities

- 1) NOAA's Office of Oceanic and Atmospheric Research (OAR) is responsible for providing capabilities for climate diagnostics, climate modeling, and climate projections through the Geophysical Fluid Dynamics Laboratory (GFDL). It is also responsible for conducting research and climate observation through its offices, laboratories, and cooperative institutes, including but not limited to the Climate Program Office and Earth System Research Laboratory (ESRL).
- 2) The NOAA Modeling and Observing Infrastructure Goal's Environmental Modeling Program is a key partner in the development of the physical climate and Earth System models that are applied toward developing a predictive understanding of the Earth System.
- 3) The NOAA Weather and Water Goal Air Quality Program is responsible for joint studies on radiation balance and air-quality-health.
- 4) The National Weather Service (NWS), through the Climate Prediction Center (CPC) and Environmental Modeling Center (EMC), is responsible for providing infrastructure to maintain operational climate predictions on intraseasonal, seasonal, and interannual time scales, and to provide a vehicle for transitioning products developed under NOAA research to operations.
- 5) NESDIS Satellite Applications and Research (STAR) is responsible for developing algorithms to retrieve carbon gas data from infrared satellite data and for satellite-based ozone-layer and aerosol-radiation monitoring.
- 6) The NOAA Office of Marine and Aviation Operations (OMAO) provides global-class research platforms, including aircraft and ships, which produce data required for CRM program requirements.
- 7) The NOAA Office of General Counsel (GC) is responsible for providing legal services necessary to enable the program to discharge its duties.
- 8) The NOAA Research Council provides guidance on research priorities with different time horizons.
- 9) The NOAA Office of Public and Intergovernmental Affairs communicates findings and results to a variety of audiences via the media.

### B. External Agency/Organization Responsibilities

- 1) The Intergovernmental Panel on Climate Change (IPCC), established by the World Meteorological Organization (WMO) and United Nations Environmental Programme

(UNEP), coordinates international assessment of scientific, technical and socio-economic information relevant for the understanding of climate change, its potential impacts, and options for adaptation and mitigation.

- 2) Numerous national and international working groups provide community-based science and implementation planning to guide NOAA's funding of climate variability and change research. These include, but are not limited to: Climate Research Committee of the National Academy of Sciences/National Research Council; US Interagency Working Groups for the various Research Element Activities of the US Climate Change Science Program; US Interagency Groups for Climate Variability and Predictability (CLIVAR), Carbon Cycle, and Global Energy and Water Cycle Experiment (GEWEX); World Climate Research Programme, sponsored by the WMO; Intergovernmental Oceanographic Commission (IOC) and the International Council of Scientific Unions (ICSU); and US Scientific Steering Committees for CLIVAR, SPARC, and GEWEX.
- 3) Academic and research communities external to NOAA support increased understanding of climate variability and change and development of improved climate prediction techniques via competitive research grants.

#### 6. END USERS OR BENEFICIARIES OF PROGRAM

Products generated by the Climate Research and Modeling Program will benefit the following end users:

- General Public – The program contributes to improved understandings of climate variability and change, including extreme events, enabling the public to plan, anticipate, mitigate, adjust, and respond appropriately. It informs and educates the public about climate.
- Businesses – The program provides data, model simulation results, and analyses beneficial to businesses developing and modifying business plans sensitive to weather and climate on timescales from intraseasonal to multiple decades. It provides operational forecasts and outlooks of intraseasonal to interannual variations and intradecadal trends.
- Government – The program supports decision-makers working on policy formulation to mitigate climate impacts and reduce costs. It provides information needed to manage natural resources and ecosystems, enhance studies on the spread of climate sensitive diseases, and contribute to mitigating natural hazards along the coast and the interior of the Nation.
- Academia – The program awards funding for extramural research and observations to support these research programs.
- International – The program provides objective information about climate change projections in support of making informed policy decisions for mitigation and adaptation strategies related to global change.